Abstract Submittal Form

Joint Army-Navy-NASA-Air Force (JANNAF)
61st JPM / 42nd SMBS / 38th PEDCS / 29th RNTS / 27th SEPS
Joint Subcommittee Meeting
19 – 22 May 2014

JPM Abstract Due Date: Monday, February 3, 2014

Title: Combustion Stability Assesments of the Black Brant Solid Rocket Motor		
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Unclassified Abstract (250 – 300 words; do not include figures or tables)

The Black Brant variation of the Standard Brant developed in the 1960’s has been a workhorse motor of the NASA Sounding Rocket Project Office (SRPO) since the 1970’s. In March 2012, the Black Brant Mk1 used on mission 36.277 experienced combustion instability during a flight at White Sands Missile Range , the third event in the last four years, the first occurring in November, 2009, the second in April 2010. After the 2010 event the program has been increasing the motor's throat diameter post-delivery with the goal of lowering the chamber pressure and increasing the margin against combustion instability. During the most recent combustion instability event, the vibrations exceeded the qualification levels for the Flight Termination System. The present study utilizes data generated from T-burner testing of multiple Black Brant propellants at the Naval Air Warfare Center at China Lake, to improve the combustion stability predictions for the Black Brant Mk1 and to generate new predictions for the Mk2. Three unique one dimensional (1-D) stability models were generated, representing distinct Black Brant flights, two of which experienced instabilities. The individual models allowed for comparison of stability characteristics between various nozzle configurations. A long standing "rule of thumb" states that increased stability margin is gained by increasing the throat diameter. In contradiction to this experience based rule, the analysis shows that little or no margin is gained from a larger throat diameter. The present analysis demonstrates competing effects resulting from an increased throat diameter accompanying a large response function. As is expected, more acoustic energy was expelled through the nozzle, but conversely more acoustic energy was generated due to larger gas velocities near the propellant surfaces.